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Book Review by L. Carr and M. Chandrasekhara of Visualizing dynamic-stall airflows

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charge to repel the particles. A small flow of control gas would carry the particles thus repelled out of the vortex generator through a hole along the axis of rotation.

The control gas and particles would pass through a pressure reducer, and the particles would be collected at atmospheric pressure. The mainstream exhaust gas would pass through a different pressure reducer before being vented to the atmosphere.

This work was done by Earl R. Collins of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, Circle 57 on the TSP Request Card.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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Refer to NPO-18127, volume and number of this NASA Tech Briefs *issue, and the page number.*

Miniature Gas-Circulating Machine

Noncontact bearings would suppress wear and contamination.

NASA's Jet Propulsion Laboratory, Pasadena, California

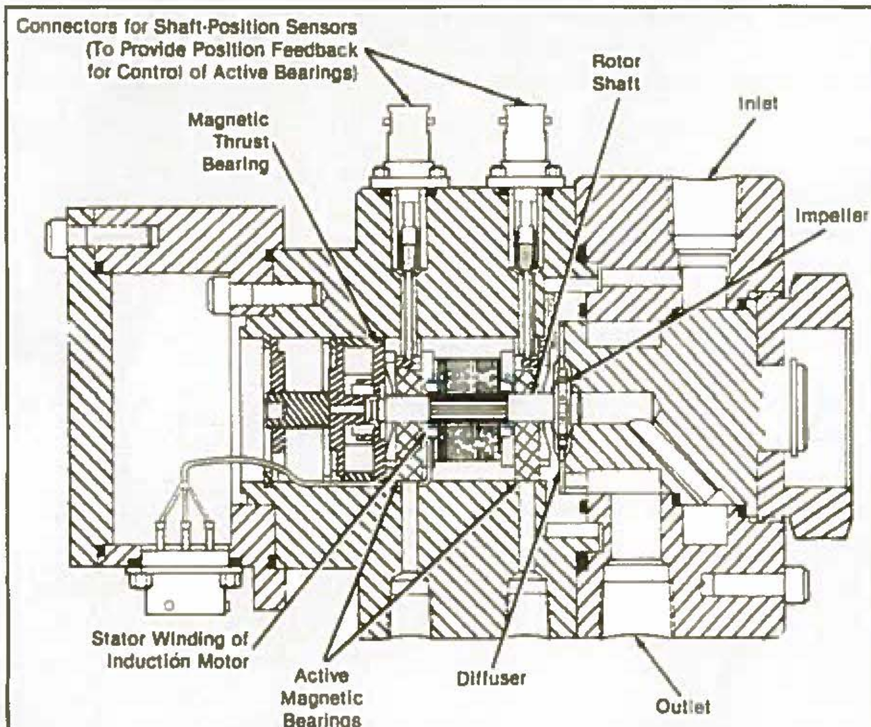
The figure illustrates a preliminary design of a proposed gas-circulating machine that would consist essentially of a centrifugal pump driven by an induction motor. The machine would be used to circulate helium (or possibly hydrogen or another gas) in a regeneration sorption-compressor refrigeration system aboard a spacecraft. Provided that the cost per unit could be reduced substantially, the machine might prove useful in terrestrial applications in which long life, reliability, and low contamination are essential.

Under the design operating conditions, the machine would pump helium from an initial pressure of about 600 psi (4.1 MPa) through a pressure rise of 3 to 10 psi (21 to 69 kPa) at a mass-flow rate of 0.25 to 0.85 g/s. The centrifugal impeller would have a diameter of 1.27 cm (0.5 in.) and would turn at 1,500 revolutions per second. The machine would consume 1 to 50 W of power, operating with an overall efficiency of 15 to 20 percent. The overall mass of the machine would be about 1 kg.

The motor would be of the induction type, which would last long and generate little, if any, contamination because there would be no brushes to wear. The rotor part of the motor would be a longitudinally serrated, magnetically soft integral part of the shaft that supports the centrifugal impeller. The rotor would be supported laterally on active magnetic or gas journal bearings and longitudinally by passive magnetic or gas thrust bearings. Thus, except during startup transients in the case of gas bearings, there would be no bearing contact and no wear, and the longevity, reliability, and cleanliness of the machine would be enhanced correspondingly.

Active magnetic bearings would be preferred under the design operating conditions. The only major disadvantage of active magnetic bearings is that a control system and power supply would be needed, and this additional equipment would entail a small additional probability of failure.

This work was done by Walter L. Swift, Javier A. Valenzuela, Herbert Sixsmith, and William E. Nutt of Creare, Inc., for **NASA's Jet Propulsion Laboratory**. *For further information, Circle 11 on the TSP Request Card.* NPO-18486



The **Miniature Gas-Circulating Machine** — essentially a centrifugal pump driven by an integral induction motor — would feature noncontact bearings for long life.

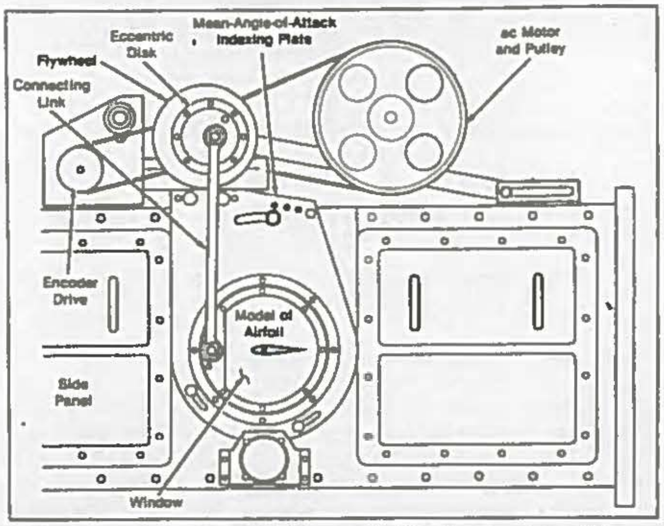
Visualizing Dynamic-Stall Airflows

Airfoils are supported and manipulated by viewing windows.

Ames Research Center, Moffett Field, California

A new wind-tunnel apparatus facilitates experiments on airfoils undergoing dynamic stall. Dynamic stall occurs when an airfoil is pitched rapidly past the static stall angle. In dynamic stall, lift can become greater than that in steady flow.

The apparatus makes it possible to visualize flow on oscillating airfoils nonintrusively. Stroboscopic Schlieren photography and holographic interferometry, for example, can be used to record flow patterns as the pitch of an airfoil is varied.



Schematic shows an airfoil mounted in the compressible, dynamic-stall wind tunnel.

The key to unobstructed visualization is the method for mounting a scale-model airfoil in the apparatus. Previously, the massive airfoil support structure—needed to withstand the large dynamic loads—blocked important parts of the airflow from observation. In the new apparatus (see figure), the mounting structure is also the viewing window: the airfoil is pin-mounted between two optical-quality glass windows. The windows are oscillated simultaneously, giving an unobstructed view of the complex flow around the pitching air-foil.

The mean angle of attack and the amplitude of oscillation can be adjusted continuously. The angle-of-attack assembly supports a motor-and-flywheel system. Eccentric disks in the flywheel establish the amplitude of oscillation.

Tapered pins in the glass windows hold the airfoil. The windows are 15.2 cm in diameter and 2.54 cm thick. They rest in magnesium frames on bearing races. A sliding seal prevents outside air from leaking into the test section.

The apparatus has yielded the first images of unsteady compressible flow over dynamically staking airfoils that accurately represent instantaneous vortex strength. The images show density gradients at the instant the photographic image is taken, unlike images obtained using older visualization methods based on the flow of smoke or hydrogen bubbles, which show only what the vortex has done to the flow in question up to the time of the photograph.

This work was done by L. Carr of **Ames Research Center** *and M. Chandrasekhara of the Naval Postgraduate School. Further information may be found in AIAA paper 89A-25511, "Design and Development of a Compression Dynamic Stall Facility.'*

Copies may be purchased [prepayment required] from AIAA Technical Information Service Library, 555 West 57th Street, New York, New York 10019, Telephone No. (212) 247-6500. ARC-12470